What is claimed is:

1. A composite electrolyte for use in electrochemical fuel cells, comprising:

(i) an inorganic cation exchange material;

(ii) a silica-based material; and

(iii) a proton conducting polymer-based material, wherein the inorganic cation exchange material comprises about 0.1 wt% to about 99 wt% of the composite electrolyte.

2. The composite electrolyte of claim 1, wherein the silica-based material comprises about 0.1 wt% to about 70 wt%, and the proton conducting polymer-based material comprises about 0.1 wt% to 99.9 wt% of the composite electrolyte.

3 The composite electrolyte of claim 1 wherein the inorganic cation exchange material is selected from the group consisting of clay, zeolite, hydrous oxide, and inorganic salt.

4. The composite electrolyte of claim 3, wherein the clay includes an aluminosilicate-based exchange material selected from the group consisting of montmorillonite, kaolinite, vermiculite, smectite, hectorite, mica, bentonite, nontronite, beidellite, volkonskoite, saponite, magadite, kenyaite, zeolite, alumina, rutile.

5. The composite material of claim 3, wherein the clay is modified to make it more compatible with organic matrices, a clay modification including exfoliation which helps to separate platelets of inorganic substance.

6. The composite electrolyte of claim 3, wherein the clay includes a modified montmorillonite consisting of montmorillonite treated with a modifier material selected from a group consisting of aminododecanoic acid, trimethyl stearate ammonium, octadecylamine, and methyl dihydroxy hydrogenated tallow ammonium.

7. The composite electrolyte of claim 1 wherein the inorganic cation exchange material comprises about 0.1 wt% to about 30 wt%, the silica-based material comprises about 0.1 wt% to about 30 wt%, and the proton conducting polymer-based material comprises about 40 wt% to 99.9 wt% of the composite electrolyte.

8. The composite electrolyte of claim 1 wherein the proton conducting polymer-based material has a linear, branched, or network morphology.

9. The composite electrolyte of claim 1 wherein the proton conducting polymer-based material includes material selected from the group consisting of acrylonitrile/butadiene/stryene rubber (ABS), styrene butadiene/acrylate/acetate polymer blends, epoxides, and a thermoplastic material.

10. The composite electrolyte of claim 9 wherein the thermoplatic material is selected from a group consisting polypropylene, polycarbonate, polystyrene, polyethylene, polyaryl ethers sulfones, poly aryl ether ketone, and polysulfones.

11. The composite electrolyte of claim 1 wherein the proton conducting polymer-based material has a functional group element selected from a group consisting of sulfonate, phosphate, carbonate, amide, and imide, wherein each such functional group element has proton conducting capabilities.

12. The composite electrolyte of claim 1, further comprising an additive selected from a group consisting of preservative, thixotropy and viscosity control agent, crosslinking agent, conditioner, plasticizer, water control agent, and proton conducting material.

13. The composite electrolyte of claim 1 wherein the inorganic cation exchange material, the silica-based material and the proton conducting polymer-based material comprise 90 wt % or more of the solids content of the composite electrolyte.

14. The composite electrolyte of claim 1 wherein the composite electrolyte when measured in the substantially dried state consists essentially of the inorganic cation exchange material, the silica-based material and the proton conducting polymer-based material.

15. The composite electrolyte of claim 1 wherein the composite electrolyte has a proton conductivity of about 0.05 S/cm or higher

16. The composite electrolyte of claim 1 wherein the silica-based material includes materials containing one or more of silica, silicate, and silicate having an organic element.

17. The composite electrolyte of claim 1 wherein the silica-based material is either colloidal silica containing discrete spheres of silica or tetraethylorthosilicate.

18. An electrochemical fuel cell, comprising:

(i) an anode;

(ii) a cathode;

(iii) a fuel supply to the anode;

(iv) an oxidant supply to the cathode; and

(v) a composite electrolyte positioned between the anode and cathode and including

(a) an inorganic cation material,

(b) a silica-based binder, and

(c) a polymer-based binder,

wherein the inorganic cation exchange material comprises about 0.1 wt% to about 99 wt%, of the composite electrolyte.

19. The electrochemical fuel cell of claim 18 wherein the silica-based material comprises about 0.1 wt% to about 70 wt%, and the proton conducting polymer-based material comprises about 0.1 wt% to 99.9 wt% of the composite electrolyte.

20. The electrochemical fuel cell of claim 18 wherein the inorganic cation exchange material comprises about 0.1 wt% to about 30 wt%, the silica-based material comprises about 0.1 wt% to about 30 wt%, and the proton conducting polymer-based material comprises about 40 wt% to 99.9 wt% of the composite electrolyte.

21. The electrochemical fuel cell of claim 18 wherein the inorganic cation exchange material is selected from the group consisting of clay, zeolite, hydrous oxide, and inorganic salt.

22. The electrochemical fuel cell of claim 21 wherein the clay includes an aluminosilicate-based exchange material selected from the group consisting of

montmorillonite, kaolinite, vermiculite, smectite, hectorite, mica, bentonite, nontronite, beidellite, volkonskoite, saponite, magadite, kenyaite, zeolite, alumina, and rutile.

23. The electrochemical fuel cell of claim 21, wherein the clay is modified to make it more compatible with organic matrices, a clay modification including exfoliation which helps to separate platelets of inorganic substance.

24. The electrochemical fuel cell of claim 21, wherein the clay includes a modified montmorillonite consisting of montmorillonite treated with a modifier material selected from a group consisting of aminododecanoic acid, trimethyl stearate ammonium, octadecylamine, and methyl dihydroxy hydrogenated tallow ammonium.

25. The electrochemical fuel cell of claim 18 wherein the polymer-based material has linear, branched, or network morphology.

26. The electrochemical fuel cell of claim 18 wherein the polymer-based material includes material selected from the group consisting of acrylonitrile/butadiene/stryene rubber (ABS), styrene butadiene/acrylate/acetate polymer blends, epoxides, polypropylene, polycarbonate, polystyrene, polyethylene, polyaryl ethers, and polysulfones.

27. The electrochemical fuel cell of claim 18 wherein the inorganic cation exchange material, the silica-based material and the polymer-based material comprise 90 wt % or more of the solids content of the composite electrolyte.

28. The electrochemical fuel cell of claim 18 wherein the composite electrolyte when measured in the substantially dried state consists essentially of the inorganic cation exchange material, the silica-based material and the polymer-based material.

29. The electrochemical fuel cell of claim 18 wherein the composite electrolyte has a proton conductivity of about 0.05 S/cm or higher.

30. A method of fabricating a composite electrolyte for use in an electrochemical fuel cell, comprising:

(i) applying onto a surface of a substrate a viscous liquid composition of (a) an inorganic cation exchange material, (b) silica-based material, (c) a polymer-based material, and (d) a solvent-dispersant;

(ii) spreading the viscous liquid composition to form a uniform thickness layer on the substrate; and

(iii) allowing the solvent to evaporate from the viscous liquid composition to yield the composite electrolyte,

wherein the inorganic cation exchange material comprises about 0.1 wt% to about 99 wt% of the composite electrolyte.

31. The method of claim 30, wherein the silica-based material comprises about 0.1 wt% to about 70 wt%, and the polymer-based material comprises about 0.1 wt% to 99.9 wt% of the composite electrolyte.

32. The method of claim 30 wherein step (ii) includes drawing the viscous liquid composition through a doctor blade assembly.

33. The method of claim 30 wherein step (iii) includes heating the viscous liquid composition.

34. The method of claim 30 wherein the inorganic cation exchange material comprises about 0.1 wt% to about 30 wt%, the silica-based material comprises about 0.1 wt% to about 15 wt%, and the polymer-based material comprises about 40 wt% to 99 wt% of the composite electrolyte.

35. The method of claim 19 wherein the inorganic cation exchange material is selected from the group consisting of clay, zeolite, hydrous oxide, inorganic and salt.

36. The method of claim 35 wherein the clay includes an aluminosilicate-based exchange material selected from the group consisting of montmorillonite, kaolinite, vermiculite, smectite, hectorite, mica, bentonite, nontronite, beidellite, volkonskoite, saponite, magadite, kenyaite, zeolite, alumina, and rutile.

37. The method of claim 35, wherein the clay is modified to make it more compatible with organic matrices, a clay modification including exfoliation which helps to separate platelets of inorganic substance.

38. The method of claim 35, wherein the clay includes a modified montmorillonite consisting of montmorillonite treated with a modifier material selected from a group consisting of aminododecanoic acid, trimethyl stearate ammonium, octadecylamine, and methyl dihydroxy hydrogenated tallow ammonium.

39. The method of claim 30 wherein the polymer-based material has a linear, branched, or netted morphology.

40. The method of claim 30 wherein the polymer-based material includes one of acrylonitrile/butadiene/stryene rubber (ABS), styrene butadiene/acrylate/acetate polymer blends, epoxides, polypropylene, polycarbonate, polystyrene, polyethylene, polyaryl ethers, and polysulfones.

41. The method of claim 30 wherein the solvent-dispersant comprises water, N-methyl pyrrolidinone, dimethyl sulfoxide, dimethyl acidimide, and dimethylformamide.

42. The method of claim 30 wherein the inorganic cation exchange material, the silica-based material and the polymer-based material comprise 90 wt % or more of the solids content of the composite electrolyte.

43. The method of claim 30 wherein the composite electrolyte when measured in the substantially dried state consists essentially of the inorganic cation exchange material, the silica-based material and the polymer-based material.

44. The method of claim 19 wherein the composite electrolyte has a proton conductivity of about 0.05 S/cm or higher.

45. A method for producing a composite membrane, comprising:

(i) grinding a sulfonated polyether ether ketone (SPEEK) and clay mixture and dissolving the mixture in a distilled dimethylformamide (DMF) to form a solution;

(ii) heating the solution until it thickens and attains a casting consistency;

(iii) degassing the solution in a vacuum oven;

(iv) casting the solution into a film on a glass surface using a doctor blade;

(v) curing the film; and

(vi) peeling the film from the glass.

46. The method of claim 45, wherein the dissolving in step (i) is performed by stirring for about 2 hours using a magnetic stir bar.

47. The method of claim 45, wherein the solution is stirred while heated, and wherein the DMF evaporates.

48. The method of claim 45, wherein the film is about 60 μm thick.

49. The method of claim 45, wherein the curing includes,

(a) annealing the film in a convection oven, and

(b) maintaining the film in a vacuum for a predetermined time period at a predetermined temperature.

50. The method of claim 45, further comprising:

storing the film in ultra-pure water until it is ready for use.